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FEBRUARY 1997
NUMBER 16

National Center for Preservation Technology and Training

UNITED STATES DEPARTMENT OF THE INTERIOR • NATIONAL PARK SERVICE

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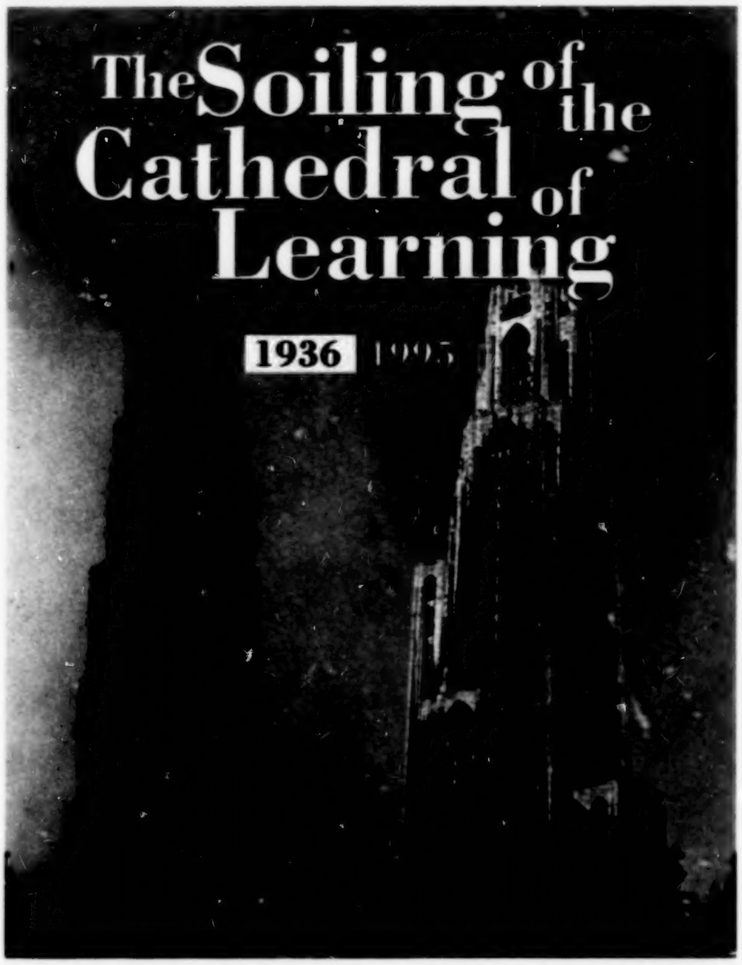
The Soiling of the Cathedral of Learning

1936 1995

NCPTT's Materials Research Program continues to fund and develop research that investigates the effects of air pollution on cultural resources. One such project is the work of Dr. Cliff Davidson at Carnegie Mellon University. Davidson, graduate assistant Vic Etyemezian, and a research team of undergraduate students are working to develop a computer model that will help us better understand the deposition of pollution on and subsequent damage to stone buildings. This project requires careful study of individual factors that affect the soiling of a building.

Davidson's group is fortunate to have an excellent example of stone architecture to study, the Cathedral of Learning. This 42-story limestone building is a National Historic Landmark located on the University of Pittsburgh campus. The building was constructed of Indiana limestone between 1929 and 1937, and is situated in the densely populated Oakland neighborhood of Pittsburgh. The Cathedral has been exposed to a long history of air pollutants over several decades. As a result, conspicuous soiling of the building is seen in the form of dark streaks on the building's facades. On first observation of the building, one notes that two sides of the Cathedral have extensive soiling while the other two sides are much less soiled. Research is underway to investigate the details of these phenomena.

In early phases of this research, Davidson identified potential sources for air pollution that affect the Cathedral. Since the time of its construction there have been numerous sources located within a few kilometers of the building. These include steel manufacturing plants that employ coke ovens and blast furnaces, a coal-burning steam heating plant, heavy motor traffic, coal-burning railroads and river boats, and a large number of domestic coal combustion sources such as home furnaces.

Other research by the group included field and laboratory studies in an attempt to define the individual conditions that have led to the soiling seen on the

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NCPTT NOTES
FEBRUARY 1997

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About NCPTT

The National Historic Preservation Act Amendments of 1992 established the National Center for Preservation Technology and Training, NCPTT's advisory board — the Preservation Technology and Training Board — and NCPTT's Preservation Technology and Training Grants program as a national initiative to coordinate and promote research, distribute information, and provide training about preservation skills and technologies.

NCPTT is established to develop and distribute preservation and conservation skills and technologies for the identification, evaluation, conservation, and interpretation of prehistoric and historic resources; to develop and facilitate training for Federal, State and local resource preservation professionals, cultural resource managers, maintenance personnel, and others working in the preservation field; to take steps to apply preservation technology benefits from ongoing research by other agencies and institutions; to facilitate the transfer of preservation technology among Federal agencies, State and local governments, universities, international organizations and the private sector; and to cooperate with related international organizations.

The **PTTBoard** is established to provide leadership, policy advice and professional oversight for NCPTT, and to advise on priorities and the allocation of PTTGrants.

The **PTTGrants** program is established to ensure an effective and efficient system of research, information distribution, and skills training in all the related historic preservation fields. Since 1994, nearly 70 PTTGrants projects have been undertaken in preservation and conservation research, training and information management.

NCPTT implements its purposes and mission in partnerships with Federal, State and local government agencies, tribal governments, State Historic Preservation Offices, Native Hawaiian organizations, educational institutions, museums, public and private non-profit institutions, and professional organizations throughout the preservation and conservation community.

NCPTT is part of the Washington office of the National Park Service under the Associate Director, Cultural Resource Stewardship and Partnerships. NCPTT is located on the campus of Northwestern State University of Louisiana in Natchitoches, Louisiana.

From the Editor

This edition of *Notes* features the research activities of NCPTT's Materials Research Program and highlights the work being done by Dr. Cliff Davidson and his team of researchers at Carnegie Mellon University. Davidson's study, which uses the Cathedral of Learning as a field site, is an excellent example of the unpredictable nature of stone research. Still, vital information can be gleaned from even the most unexpected results.

A special insert report on the highlights of the Eight International Congress on Deterioration and Conservation of Stone by ElizaBeth Bede is included in this edition of *Notes*. This report provides important information on the most current research developments within this field.

NCPTT is also pleased to announce the spring call for 1997 PTTGrants. This round of competition features the newest project types, including conference support, publication support, technology transfer, and environmental studies. For more information, see page 6.

NCPTT's Research Program reviews work by the Center for Advanced Spatial Technologies at the University of Arkansas - Fayetteville on "Recording archeological materials using stereo photography and softcopy photogrammetry". This promising low-cost technique was supported through the 1994 PTTGrants program.

NCPTT's Information Management news column discusses the issue of copyright law and the Internet. This timely topic touches computer users far and wide.

NCPTT's Training Program highlights products of the PTTGrants program and features collaborative efforts with the Statewides Partnerships program.

The Soiling of the Cathedral of Learning

(continued from page 1)

Cathedral. As previously reported in *Issue 7 of Notes*, Davidson's group identified the key chemical species of pollutants, initiated studies on the methods of pollutant transport to the surface of the Cathedral, mapped soiling patterns currently seen on the building, and investigated historic photographs to identify changes seen in the soiling patterns at the Cathedral.

Key chemical species that continue to be studied include particulates and gases. Airborne particles, such as sulfates, nitrates, and carbon, are measured at various locations on the building. Also, size distributions of the particles and total particle counts are determined. Gaseous pollutants being studied include sulfur dioxide and nitric acid.

Davidson and Etyemezian theorized that the concentrations of key chemical species might provide us with a better understanding of present day sources affecting the building as well as insight into pathways of delivery of pollutants to the building surfaces. Efforts in the past year have focused on a few specific experiments to test the theory.

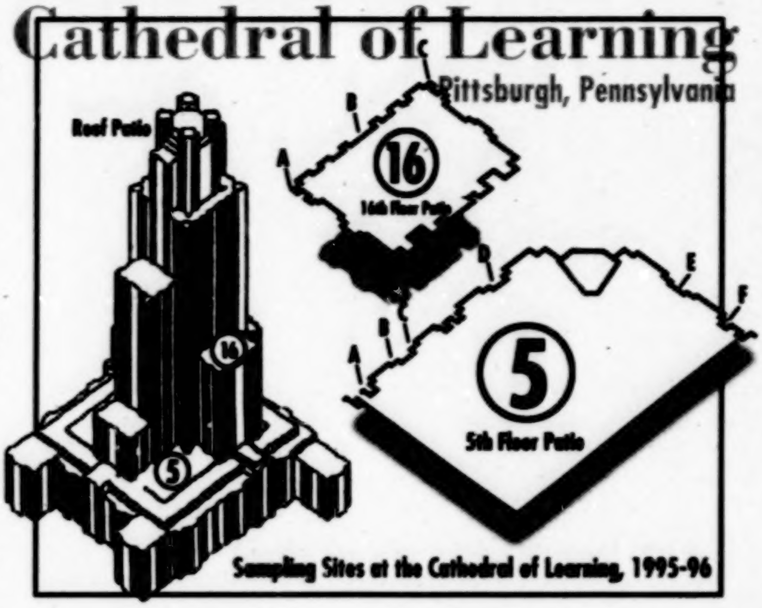
First, Davidson's group determined whether airborne pollutant concentrations of the key species varied with height on the building. Second, they investigated whether the actual dry deposition of sulfur dioxide varied with height. Three locations were chosen for sampling -- the south-facing fifth floor patio, the east-facing sixteenth floor patio, and the patio on the roof (see Figure at right).

These experiments, called vertical gradient experiments, were conducted on four separate occasions for the period from November 1995 to August 1996. The experiments were scheduled so that the data might reflect changes associated with the different seasons of the year. Airborne concentrations of elemental and organic carbon particles were measured during the Fall and Winter experiments only. For the Spring and Summer experiments, membrane filters were used in place of the carbon measurements to obtain samples of the particulates for later analysis by Scanning Electron Microscopy (SEM). Laser particle counters were used to provide real-time data for number concentrations of particles with diameter > 0.5 mm and > 5 mm. Each set of experiments also included two two-week measurements of SO_2 deposition fluxes. Deposition flux and laser particle counter measurements were conducted on the fifth floor and sixteenth floors only.

The existence of variation in pollutant concentrations with height, also known as vertical concentration gradients, requires that two conditions hold true. First, emissions from nearby sources must be sufficiently large to increase pollutant concentrations above the urban background. Second, pollutants emitted from these sources must be transported to the Cathedral before dispersion causes spatial homogeneity.

The results of the vertical gradient experiments indicate that there are no significant differences in concentration as a function of height along the building for any of the airborne species measured. Sulfate and nitrate particles and nitric acid gas are generally products of other pollutants found in the atmosphere and are therefore considered secondary pollutants. Airborne concentrations of these species are expected to be spatially homogeneous. These sulfates and nitrates are sometimes associated with coarse particles, in part due to sorption of gaseous sulfur dioxide and nitric acid onto alkaline soil dust. The absence of a concentration gradient suggests that if these species are associated with coarse particles, there is adequate mixing to distribute them over the height of the Cathedral.

The fact that elemental carbon does not exhibit a concentration gradient suggests that motor vehicle



Sampling Sites at the Cathedral of Learning, 1995-96

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Recording archeological materials using stereo photography and softcopy photogrammetry

With the passage of the Native American Graves Protection and Repatriation Act of 1990, many archeologists have expressed concern that artifacts may be repatriated before complete analysis or adequate recording is undertaken — resulting in the loss of potentially significant archeological data. The ability to collect accurate measurements of archeological artifacts and to generate a permanent record from which information can be extracted is fundamental to the practice of archaeology. For this reason there has always been a critical need for a rapid, low cost method of accurately measuring the physical dimensions and surface features of archaeological artifacts. One such method already in use is stereo-photogrammetry.

Stereo-photogrammetry is based on the concept of stereo viewing, which derives from the fact that humans beings naturally view their environment in three dimensions. Each eye sees a single scene from slightly different positions. The brain then calculates the difference and reports the third dimension. This process can be easily simulated by taking two photographs — stereo pairs — of the same scene with two identical cameras separated by a certain distance. By placing the photographs side by side and focusing each eye on its corresponding image it is possible to perceive the three dimensional effect. Specially designed glasses or binoculars also may be used to enhance viewing. This is the basis of the ViewMaster viewers children's toys, which are simply binoculars that allow one to view stereo images mounted on disks.

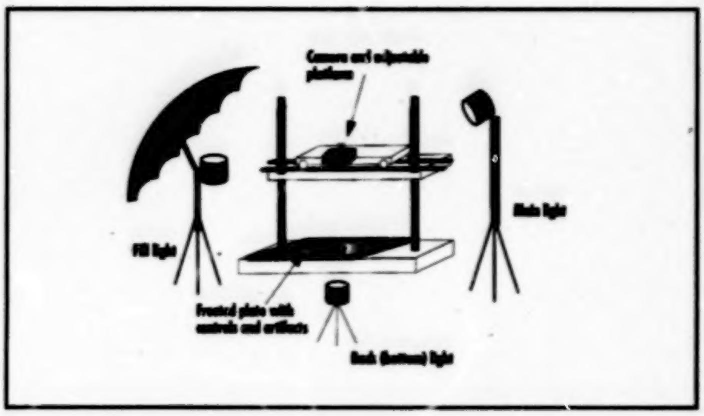
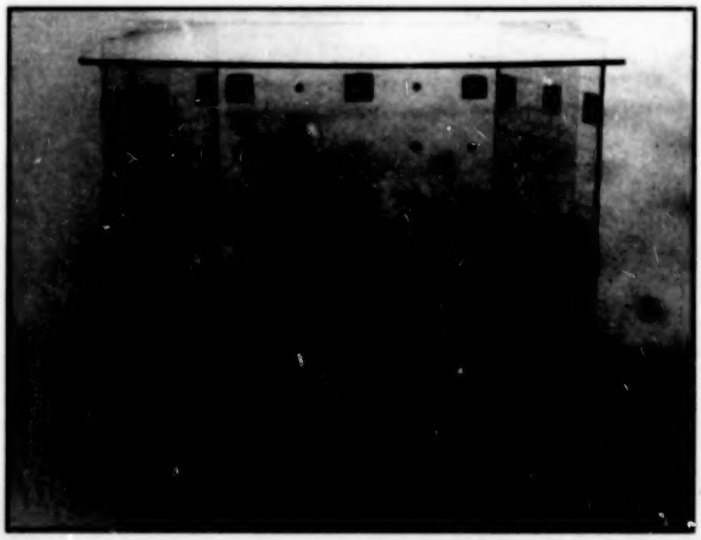

Camera and adjustable platform
Fill light
Main light
Frosted plate with controls and artifacts
Back (bottom) light

Figure 1: Low-cost photography setup



Two kinds of information can be extracted from stereo pairs: (1) quantitative data such as distances, elevations, angles, areas and volumes, and (2) qualitative data such as feature and pattern identification. These processes are called metric and interpretive photogrammetry, respectively. Today, both quantitative and qualitative data can be readily obtained using computer image capture and processing technologies and three dimensional modeling software. Unfortunately, this technology is costly and requires highly specialized equipment. As a result, the field of photogrammetry has been restricted primarily to trained professionals. Recent developments in the computer manipulation of stereo photographs, often referred to as "softcopy" photogrammetry, have reduced costs significantly, and new software packages available for either personal computers or powerful graphic workstations now allow almost anyone to process and analyze stereo images.

The Center for Advanced spatial Technologies at the University of Arkansas - Fayetteville recently has studied the feasibility of utilizing stereo-photogrammetric techniques and software to gather metric data from photographic images of archeological artifacts. Stereo pairs of various archeological artifacts including bone materials were photographed and scanned into a digital format. Three dimensional images from which measurements could be taken were then created using photogrammetric software.

Objects were photographed using inexpensive non-metric cameras. A simple photographic set-up that could be adopted by any museum or professional archeologist was used to generate the stereo pairs (Figure 1). The photogrammetric processing of the images was performed using a highly sophisticated apparatus consisting of an Intergraph Image Station and a Zeiss Intergraph Photoscan high resolution scanner.

The study found that in order to obtain reliable measurements, objects must be photographed within a well-defined three dimensional reference system or control field, as seen in Figure 2. The accuracy of the measurements derived from this system largely depended upon the accuracy of the control field surrounding the photographed artifacts. The more accurate the three dimensional control field, the more accurate the measured results. In general, the results were well within an acceptable range of error, particularly for small objects. Differences between manual and digital measurements for the x and y axes were less than one millimeter for distances ranging between 0 and 15.5 centimeters. In general, depth measurements were accurate within seven to ten percent. This percentage of error is considered acceptable for objects with a depth less than three centimeters since it would result in an error of only three millimeters. For larger objects, however, such as a pot with a diameter of fifteen centimeters, digital measurements are considered unsatisfactory since they are accurate only within one or two centimeters. The use of higher quality cameras and lenses with better optics, however, greatly reduces these errors and yields more accurate measurements.

The study concluded that standard photographic techniques when used in combination with softcopy photgrammetry can be used to accurately record some archeological materials and have potential for archiving images, collecting measurements and analyzing artifacts that might not be available for future study.

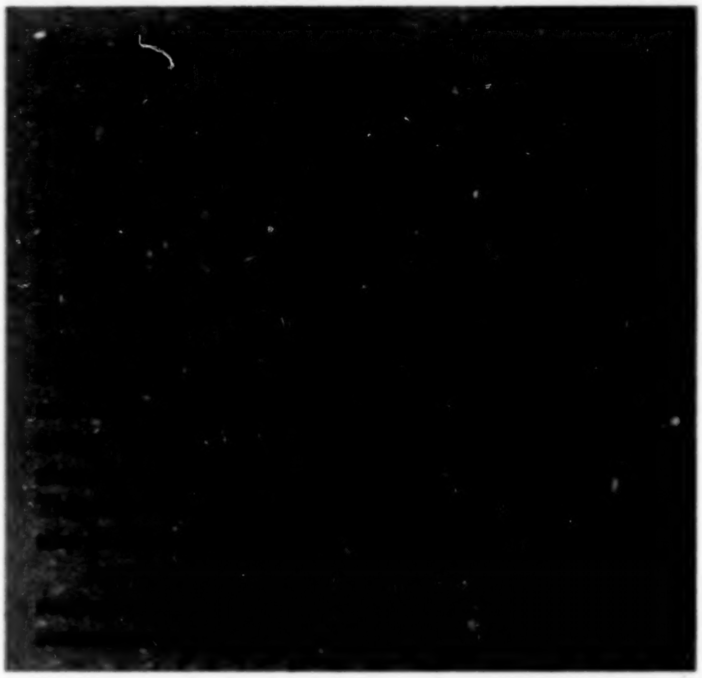
This articles summarizes a report by the Center for Advanced Spatial Technologies, University of Arkansas - Fayetteville. The project was supported by the 1994 PTTGrants program. Copies of the report (NCPTT Publication No. 94-03), which includes equipment and software specifications, may be obtained from Mark Gilberg, Research Coordinator, NCPTT.

The Soiling of the Cathedral of Learning

(continued from page 1)

emissions from adjacent streets are either rapidly mixed or else do not contribute significantly to the measured concentrations. Likewise, the presence of the nearby coal-fired steam plant does not cause differences in sulfur dioxide levels among the three sampling locations.

In contrast to the pollutant concentrations, the actual deposition of the sulfur dioxide gas to the surface of the building did consistently vary from location to location on the building. The deposition fluxes were measured at several locations on the fifth and sixteenth floor patios. The deposition fluxes were different at different heights on the building and at different locations on each patio. The highest deposition velocities were measured at



locations that corresponded to the outside corners of the patios. These differences in deposition velocity are probably a result of turbulent eddies caused by flow patterns and recirculation zones at the outside corners of the patios. It is interesting to note that, at three of the four outside corners, no soiling was present on the building surfaces. This seems to imply that rain washing and erosion of the surface mobilizes pollutants to other locations.

While the experiments do not allow us to identify the key source or sources currently contributing to the soiling of the Cathedral as we had hoped, they still provide us with important information since they do allow us to identify individual variables that contribute to the patterns seen.

These experiments have shown that a better understanding of the rain delivery patterns and air flow and circulation patterns around the Cathedral walls is needed to better define the soiling patterns seen on the building. Because of its enormous size, the presence of the Cathedral alters the upstream air flow profile. During rain storms some parts of the building experience concentrated rain intensity whereas others are sheltered. Future experiments at the Cathedral will attempt to model rain delivery patterns. This will involve two major steps: first is the estimation of the air flow patterns around the building; second is the incorporation of rain drop size distributions and force balance into the model.

For more information regarding this research, please contact—

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—Mary F. Striegel
Cliff Davidson
Vicken Etyemezian

1997 PTTGrants: Spring Call for Proposals

NCPTT announces its Spring call for 1997 Preservation Technology and Training Grants. From this round of competition, PTTGrants will be awarded for conference support, publications support, technology transfer, and environmental research studies.

Conference support projects shall support conferences, workshops and symposia that seek to share recent findings in research, education or information management, or to promote transfer of technology from other disciplines to historic preservation. Support by multiple organizations is encouraged. Requests for support may include costs for planning and coordinating the event and for publishing proceedings.

Publications support projects shall collate, synthesize, review or interpret existing knowledge in subject areas relevant to preservation and conservation. Project work shall result in published monographs or articles suitable for publication in peer-reviewed journals.

Proposals for **technology transfer** projects will be considered for exploratory or preliminary research that seeks to facilitate the transfer of new or emerging technologies developed for use in other disciplines to the field of preservation and conservation.

Under NCPTT's Materials Research Program, **environmental research** proposals will be considered for basic and/or applied research that focuses on — (1) investigating the role of outdoor atmospheric pollution in cultural resources decay processes; (2) developing management strategies to minimize the effect of pollutant damage; or (3) new conservation treatments for application within the preservation community.

Grants will be awarded on a competitive basis, pending the availability of funds. **The proposal deadline is April 15, 1997.**

1997 PTTGrants: Spring Call information will be mailed to *NCPTT Notes* subscribers soon; information also is available via fax-on-demand, via NCPTT's World Wide Web and gopher sites, and via return e-mail.

Via fax-on-demand, telephone NCPTT's fax-on-demand system at 318/357-3214, and follow the recorded instructions to receive the 1997 PTTGrants: Spring Call information by return fax.

Via Internet — For World Wide Web access, the address is http//www.cr.nps.gov/ncptt/; for gopher access, the address is gopher://gopher.ncptt.nps.gov. Via return email — send to pttgrants@alpha.nsula.edu, leaving the subject line and message area empty. You will receive the guidelines automatically.

Rakesh Kumar joins NCPTT's Materials Research Program

NCPTT welcomes Rakesh Kumar to the staff of the Materials Research Program as a Research Associate. Rakesh holds a doctorate in organic chemistry from Gorakphur University in India.

Most recently, Rakesh has worked as a research fellow with the Getty Conservation Institute studying consolidants and biocides for the conservation of stone. While at GCI, he focused his efforts on solving conservation problems at the ancient Maya site, Xunantunich, in Belize. This site showed numerous signs of biodeterioration and decay of limestone substrates. Rakesh evaluated chemical consolidants and biocides, in the laboratory as well as in-situ, for the stabilization of the site.

Rakesh has worked with Dr. Clifford Price at the Institute of Archaeology, London, where he examined the interaction of silanes and stone and investigated the effects of common salts on the polymerization of silanes.

Rakesh brings to NCPTT a strong understanding of the chemistry of consolidants used in architectural conservation. He is assisting Mary Striegel with operation of the NCPTT Environmental Exposure Facility, and will study the effects of consolidation on the deposition of air pollution on calcareous stone.

NCPTT's New Interns

Kevin Ammons

NCPTT announces the appointment of a new student assistant, Kevin S. Ammons. Kevin is pursuing a graduate degree in history from Northwestern State University of Louisiana, and also owns and operates a construction business. Among his NCPTT tasks are the completion of the database for Louisiana *Save Outdoor Sculpture!* project and the index database of scientific abstracts for the Materials Research Program. Kevin is a recipient of academic graduate awards, has presided over an historical honor society and has experience in teaching and computer skills as a graduate assistant in NSU's Social Sciences Department.

Jeffery Fabian

NCPTT welcomes Jeffery Fabian to its staff as assistant to NCPTT's Information Management Program. Jeff is a student at Northwestern State University of Louisiana with a major in Psychology and a minor in Computer Science, with plans to continue his studies at the graduate level. He is a member of two national honor societies and a self-described "computer phreak".

Copyright Law and the Internet

This article continues a regular series of articles on the Internet. The application of copyright law to the world of cyberspace is discussed in this issue. If you have suggestions for Internet-related topics that you would like to see discussed in this column or if you have a question about matters addressed here, please contact NCPTT via e-mail or regular mail.

Application of copyright law to the Internet currently is a widely discussed topic. There is much controversy about how standard copyright law affects work done on the Internet. This article will briefly touch on what copyright is and some issues in relation to cyberspace.

Copyright law "...prevents you from copying in its entirety a work that's been created by others, without their permission." (From http://www.msnbc.com/news/19689.asp) A few of the types of works protected by copyright law include books, music, art, movies and software. On the Internet, text and images on Web pages, e-mail postings to newsgroups and discussion lists, private e-mail, and corporate e-mail are copyrighted. Copyright does not have to be applied for or registered; it applies as soon as the work is created. But copyright law is apparently not straightforward and often can be vague, so the application of copyright law to electronic documents is doubly difficult.

Current copyright law applies the same way in the electronic world as outside the Internet — that is, once a work has been "...fixed in a tangible form of expression" (From US Copyright Office, ftp://ftp.loc.gov/pub/copyright/circs/circ01.html), it cannot be copied without the permission of its author. There are those who dispute this interpretation, but their ideas have not been incorporated into law. So when or if you download images from Web pages or forward e-mail messages from one discussion list to another, compliance with copyright law may be an issue.

There are three cases in which the copying might be legal: 1) when it is *explicitly allowed* by the copyright owner, 2) when there is an *implied license*, or 3) when it is a *fair use*.

The first case simply means that the author has stated that copying of the work is allowed. This can be on an individual basis or globally to all users.

In the second case, an implied license is created when the copyright owner "...acts in such a way that *reasonable people would assume that he's allowing them to make copies*..." (From Cyberspace Law for Non-Lawyers, http://www.counsel.com/cyberspace/copyright.html). An example cited is a letter to the editor of a newspaper. Most people would assume that the writer is allowing it to be copied and published. In the case of messages posted to a discussion list, it is not clear whether implied license would be applicable; it may depend on the list and its normal operations.

In the third case, the fair use doctrine uses a series of questions to determine whether use of documents is legal or not. In general, these three basic rules apply: "1) copies of small excerpts tend to be FAIR, 2) copies for systematic news reporting, criticism, or parody tend to be FAIR, and 3) copies of unpublished works tend to be UNFAIR" (From Cyberspace Law for Non-Lawyers, http://www.counsel.com/cyberspace/copyright.html). However, as stated above, copyright law is vague and these are not hard and fast rules.

The issue of copyright on the Internet is far from settled. One person's interpretation of fair use or implied license may not agree with others'. The issues continue to be discussed, but probably will not be settled for some time. The World Intellectual Property Organization, a United Nations organization, recently met in Geneva, Switzerland, to undertake international copyright negotiations. Many organizations, including the Association of Research Libraries, the American Library Association, the Association of Law Libraries, and the Electronic Frontier Foundation, have expressed concerns with the treaties developed as a result of the Swiss meetings.

If you are interested in finding out about copyright law in cyberspace, these are a few of the many Internet resources available: Electronic Frontier Foundation (http://www.eff.org), FindLaw (http://www.findlaw.com/), Cyberspace Law for Non-Lawyers (http://www.counsel.com/cyberspace), the misc.int-property newsgroup, and the CNI-COPYRIGHT mailing list (to subscribe, send e-mail to listproc@cni.org with this message: subscribe cni-copyright firstname lastname). These sites contain links to other sites containing a wealth of information on copyright and other legal issues in cyberspace. Just point your browser and go.

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Building Community - A New Future for Architecture Education and Practice

Ernest L. Boyer and Lee D. Mitgang
1996. The Carnegie Foundation for the Advancement of Teaching
(Distributed by California Princeton Fulfillment Services, 1443 Lower Ferry Road, Ewing, NJ 08618, telephone 800/777-4726, facsimile 800/999-1958)

This recently-completed Special Report by the Carnegie Foundation for the Advancement of Teaching was commissioned by the American Institute of Architects, the Association of Collegiate Schools of Architecture, the American Institute of Architecture Students, the National Council of Architectural Registration Boards and the National Architectural Accrediting Board. The project began in 1987 with an idea for an independent study of professional education and practice, an concluded with publication of the Special Report in 1996.

The authors propose a "new framework for renewing architecture practice based on seven separate but interlocking priorities", which "if widely embraced … would help promote a more fruitful partnership between educators and practitioners that would not only enhance the competence of future architects but also lead the profession into more constructive engagement with the most pressing problems of our communities, our nation, and our planet."

The author's priorities are presented as seven essential goals —

Goal One, *An Enriched Mission*, encourages architectural education and practice to better align with current cultural values -- which today emphasize the rebirth and revitalization of our cities and respect for sustaining resources.

Goal Two, *Diversity with Dignity*, encourages full exploitation of the interdisciplinary potential for architectural education and practice, and the development of architectural scholarship.

Goal Three, *Standards without Standardization*, proposes that academic diversity is the viable unified theory of the nation's architectural programs, and encourages building on these diverse strengths.

Goal Four, *A Connected Curriculum*, returns to the theme of integration, application and discovery of architectural knowledge, and how interdisciplinary connections better serve society's needs.

Goal Five, *Climate for Learning*, addresses the status of architectural education and the potential for enhanced learning.

Goal Six, *A Unified Profession*, addresses the status and potential for life-long architectural learning, beginning in school and extending throughout practice.

Goal Seven, *Service to the Nation*, states the need to more fully extend the effects of sound architectural education to the American culture at-large.

The seven goals are based on the authors' extensive research into architectural education and practice, analysis of their findings, and interpretation of the findings' significance.

As presented in this study, architectural curricula of the 1990s remain overwhelmingly focused on the design studio — and the potential for preservation's contributions to architectural education and practice remains largely unexplored. Neither preservation as academic pursuit nor as career figure prominently in the study's research, or in the study's vision for a new future for architecture education and practice — a particular curiosity when preservation programs within schools of architecture are a prominent change in architectural curricula in the last 20 years.

In introducing the study's thesis, the authors state that the "profession that for much of its history prized the new and unique now finds more and more of its members engaged in preservation and renovation." But preservation is not strongly integrated into the study's essential goals. In Goal One, *An Enriched Mission*, cites the development of preservation specializations in twenty-three architectural degree programs and encourages architecture schools are encouraged "to prepare graduates to apply their design knowledge to preservation and renovation as much as the creation of 'newness'." In Goal Four, *A Connected Curriculum*, the study encourages more flexible curricula that accommodate specialized programs that reflect current needs, including history and preservation. But, in the end – in Goal Seven, *Service to the Nation* –, preservation is seen as growing out of late 1960s civic activism and largely relegated to the worlds of *pro bono* and public service. With such a reputation, it is not surprising that a practitioners often find preservation a difficult business proposition.

The study, however, offers some relief in proposing that a new (and better) future for architecture — and preservation — will result from enhanced professionalism founded on life-long learning, interdisciplinary approaches to education and practice, and development of a solid theoretical and research base for education and practice. The study focuses particularly on the role of fundamental and applied research in better securing architecture's place in the university setting and better serving the development of fully professional practitioners.

The study is disappointing when read from a

Continued on Page 11 ➡

PTTGrants Projects in Training

Culture Shock: Fire Protection for Historic and Cultural Property

A PTTGrants video; NCPTT Publication No. 95-01.

Culture Shock, the PTTGrants program video on fire protection for historic properties, was produced by Boston University with funds from the 1995 PTTGrants program. The 22-minute video demonstrates the vulnerability of historic structures to fire and provides a general description of how fire protection and detection devices work. The video's footage of institutions with properly installed adequate systems helps dispel the belief that fire protection equipment is aesthetically unappealing or intrusive in historic properties. Copies of the video are still available. Contact Marvis Chance, in NCPTT's Training Program.

Culture Shock will be available later this month from the Fire Protection Association (FPA), the national fire safety organization of the United Kingdom. FPA is one of four component parts of the Loss Prevention Council (LPC), an umbrella organization for a wide range of technical groups that includes the National Approval Council for Security Systems, LPC Laboratories and the Loss Prevention Certification To obtain Culture Shock in the UK, contact Michael Gale, Publications Manager, Loss Prevention Council, telephone (in the UK) 0101 207 2345; e-mail info@lpc.co.uk.

A scene from ***Walls of Stone***, **an instructional video on preserving drystone walls and rock fences.** ***Walls of Stone*** **is one of several projects sponsored by the PTTGrants program.**

Walls of Stone

A PTTGrants video; NCPTT Publication No. 96-01.

Kentucky Heritage Council, Dry-Stone Masonry Institute and KET, the Kentucky Network recently completed *Walls of Stone*, an instructional video on preserving drystone walls and rock fences. Funded with a 1996 PTTGrants award to Kentucky Heritage Council, the video is a primary training resource, providing graphic instruction on how to repair, rebuild and relocate stone walls and rock fences. In addition to providing training to practitioners, the video explains fence and wall construction to archeologists, engineers, preservationists and conservators.

Many states have walls and fences that are important to our understanding of history and cultural landscapes. In many states these structures are endangered due to lack of preservation skills and the understanding of their importance. *Walls of Stone* will help to preserve and protect an important part of our heritage that survives in Federal and state parks, land preserves and tribal reservations and in historic landscapes throughout the United States. For a copy of the video, contact Dry-Stone Masonry Institute of America, Inc., 606/272-4807.

Simple Book Repair Manual

A PTTGrants Internet resource; NCPTT Publication No. 95-02.

With funding through the 1995 PTTGrants program, the Preservation Services Department of Dartmouth College Library has converted its training manual on book repair into hypertext, making it accessible on the World Wide Web. The Simple Book Repair Manual Web site is available at the following address: http://www.dartmouth.edu/~preserve/tofc.html.

The Simple Book Repair Manual provides text and illustrations of ten basic repairs including book cleaning and erasing pencil marks, torn pages, hinge repair, hinge tightening and binding a single signature pamphlet. Library and archive staff and others with access to the Internet can visit the Web site to view training materials and book conservation resources. The project promotes an understanding of simple book repair techniques and is an important resource in collections conservation.

NCPTT and Statewides Partnerships

The Statewides Partnerships overall goal is to develop fully professional non-profit preservation organizations — known as statewides — in all states and US Territories. The sum of the individual statewide organizations will be a national integrated network of membership preservation organizations. NCPTT is assisting the National Trust for Historic Preservation in the development of statewide organizations — towards creating another means by which the results of NCPTT's work may reach the American preservation public.

Preservation training and education activities are prominent components of NCPTT's collaboration with the National Trust on the Statewides Partnerships program. In 1997, NCPTT's co-sponsorship of a Preservation Leadership Training workshop and a series of Preservation Weekends throughout the United States will focus on NCPTT's and the National Trust's Statewide Partners.

Preservation Leadership Training

Natchitoches, Louisiana
April 5-12, 1997

Preservation Leadership Training returns to Natchitoches in Spring 1997. Co-sponsored by NCPTT and the National Trust for Historic Preservation, the 1997 Natchitoches PLT will emphasize participation from Statewide Partners. The 1997 PLT builds on the success of last year's PLT workshop in Natchitoches, attended by government officials and staff and board members of non-profit and government preservation organizations. As in 1996, participants will spend a week in Natchitoches focusing on creative responses to preservation situations.

The 1997 Natchitoches PLT participants will address fundamental concerns facing preservation leaders nationwide. Through the vehicle of group projects, participants will examine preservation topics in the Cane River Heritage Area in Natchitoches Parish. PLT participants develop skills and learn about methods and practices that enhance the study area and their own communities.

For more information on the Preservation Leadership Training program, contact Cydne Nash , 202/588-6067.

Preservation Weekends

Portland, Oregon
June 20-22
Others to be announced

NCPTT will co-sponsor a series of three **Preservation Weekends** throughout the United States, beginning this June in Portland, Oregon. Preservation Weekend/ Austin in April 1996 provided an intensive two-day training opportunity for owners and managers of historic homes and properties. The Austin workshop provided instruction in preservation philosophy, financial incentives for preserving historic houses, architectural history of Texas and demonstrations of various building crafts. As part of NCPTT's collaboration on the National Trust for Historic Preservation's Statewides Partnerships program, 1997 Preservation Weekends will build on the success of Preservation Weekend/Austin and focus on developing the preservation expertise of Statewide members and others interested in preservation.

For **Preservation Weekend/Portland**, Oregon's statewide preservation organization, the Historic Preservation League of Oregon, will take the lead in planning the June 1997 event. The workshop will emphasize issues in preservation theory and practice ranging from financial concerns to hands-on rehabilitation and restoration.

For information on Preservation Weekend/ Portland, contact Paula Cook at NCPTT. Watch future editions of *Notes* for details on other Preservation Weekends in 1997.

Jumpstart

Jackson, Mississippi
March 9-12
Harrodsburg, Kentucky
April 13-16
Columbia, South Carolina
May 18-21

During Spring 1997, the Southeastern Museums Conference (SEMC) will conduct a multi-faceted training program for museums in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia and West Virginia. Funded through a Professional Services grant from the Institute of Museum and Library to SEMC, Jumpstart will assist museums still in the planning phases, museums less than two years old and older small museums contemplating major changes or expansions. NCPTT is co-sponsoring the program and NCPTT training coordinator Fran Gale will serve as evaluator for the seminars.

The program is based on the Louisiana Association of Museums' highly successful statewide pilot program. Project activities will include a three-and-a-half-day training seminar combining classroom instruction with case studies, peer-to-peer mentoring, individual consultations, follow-up evaluations of institutional progress, and compilation of extensive training and resource materials. Peter S. LaPaglia, a private consultant in Murfreesboro, Tennessee, will provide curriculum design and serve as the Jumpstart's Primary Instructor. Registration is $200. For more information, contact Judyth Demarest, Jumpstart Project Coordinator, telephone 504/383-5042, facsimile 504/343-8669, e-mail SEMCdirect@aol.com.

Preservation Institute workshops

Baton Rouge, Louisiana
April 12-15
New Orleans, Louisiana
TBA

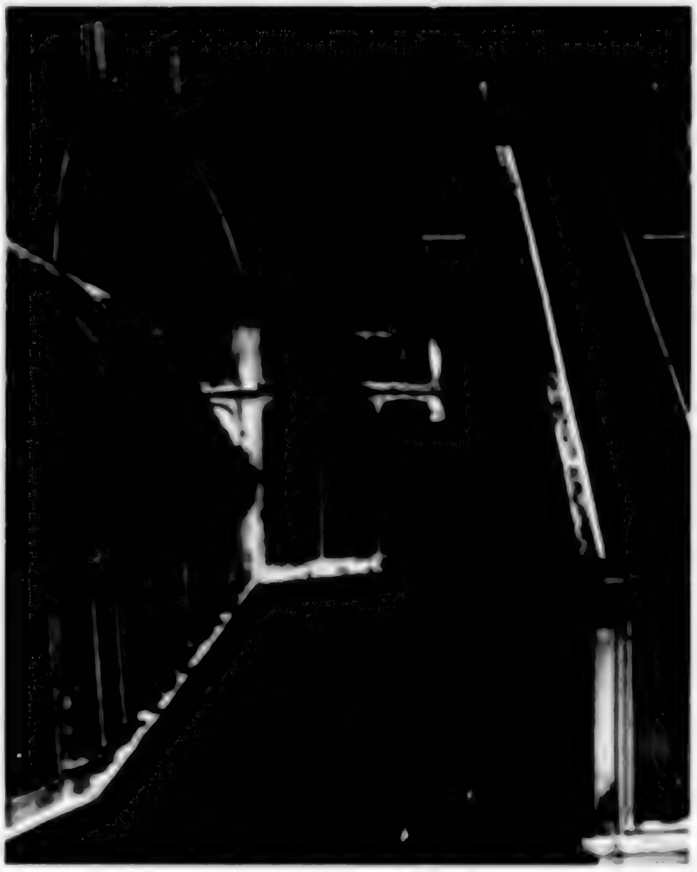
Preservation Institute of Historic Windsor, Inc. returns to Louisiana this Spring to conduct six workshops on: decorative finishes, preservation philosophy, building design and technology, brick repointing and classical moldings. Decorative finishes workshops are scheduled for April 12-15 at Magnolia Mound Plantation in Baton Rouge, Louisiana. Other workshops will be held in New Orleans with Preservation Resources Center serving as host, at dates and locations to be announced. For more information contact Historic Windsor, 802/674-6179.

The Windows Conference and Exposition for Historic Buildings II

Washington, DC
February 19-21

The Windows Conference and Exposition II provides a special opportunity to obtain essential information on current practices and technology for rehabilitating windows in historic buildings, and to re-examine traditional methods and approaches.

Conference sessions include the results of two Preservation Technology and Training Grants in research: *Retain or Retire? A Field Study of Energy Impacts of Window Rehab Choices* (1994 PTTGrants award to the Vermont Division of Historic Preservation), and *Protective & Destructive Glazing Systems over Stained Glass* (1994 PTTGrants award to Inspired Partnerships).



The conference is presented by the National Park Service's Heritage Preservation Services. For more information, visit the National Park Service's World Wide Web site (http://www.cr.nps.gov), or write Historic Window Conference, POB 77160, Washington, DC 20013-7160.

Building Community

(continued from page 9)

preservation perspective. Preservation's present and future roles in architectural education and practice are neither prominent nor distinct.

And therein lies the challenge. Preservation colleagues certainly should study the report's seven essential goals and consider the potential for integrating preservation principles and skills into architectural education and practice. Preservation colleagues also should consider the [illegible] elevating both the [illegible] (and preservation) [illegible] the status and [illegible] (and preservation) [illegible] the community should [illegible] large — and support [illegible] and research they will [illegible] architecture and pres[illegible]

— John [illegible]

Our Mission

The National Park Service
The National Park Service is dedicated to conserving unimpaired the natural and cultural resources and values of the National Park System for the enjoyment, education, and inspiration of this and future generations. The Service is also responsible for managing a great variety of national and international programs designed to help extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.

The National Center for Preservation Technology and Training
The National Center for Preservation Technology and Training promotes and enhances the preservation of prehistoric and historic resources in the United States for present and future generations through the advancement and dissemination of preservation technology and training.

NCPTT, created by Congress, is an interdisciplinary effort by the National Park Service to advance the art, craft, and science of historic preservation in the fields of archeology, historic architecture, historic landscapes, objects and materials conservation, and interpretation. NCPTT serves public and private practitioners through research, education, and information management.

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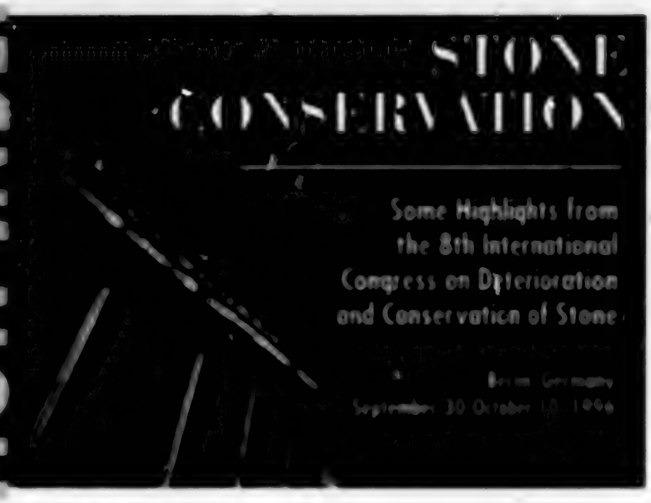

STONE CONSERVATION

Some Highlights from the 8th International Congress on Deterioration and Conservation of Stone

Berlin, Germany
September 30 October 10, 1996

***ElisaBeth Bede** was the 1996 NCPTT Research Fellow within the Materials Research Program. As part of her fellowship, Bede attended the Berlin Congress and developed the following report for NCPTT.*

She currently is working on her doctorate degree in Conservation Science at the University of Delaware, focusing on the study of air pollution deposition on carbonate stone surfaces. She continues to be actively involved in the development and operation of NCPTT's Environmental Exposure Facility. In 1990 she completed her master's degree in historic preservation at the University of Pennsylvania after graduate studies in architectural design at Virginia Polytechnic Institute. Bede is a vital member of the NCPTT Materials Research Program team.

The 8th International Congress on Deterioration and Conservation of Stone was held in Berlin, Germany from September 30 through October 10, 1996. The Congress hosted representatives from every continent with over 190 presentations proffering the current state of knowledge of stone deterioration processes and treatment protocols. The presentations covered the synergetic effects of stone properties and decay mechanisms in various environments.

I. EVALUATION OF WEATHERING

In his keynote address, Erhard Winkler, of the University of Notre Dame (United States), stressed the significance of A. Kieslinger's studies of the effects of moisture on decay that revolutionized the understanding of stone weathering. His investigations have led to a proliferation of studies on the chemical, physical and catalytic ramifications of moisture transport in stone. The study of stone deterioration by moisture has been a monumental undertaking – and studying moisture is only one of the many factors faced by stone conservators. Others issues range from environmental effects – such as moisture penetration, thermal cycles, and pollutants – to analyzing a variety of stone types that differ in chemical and physical properties. Studying these components on the macro- and micro-scale is a task with which stone researchers have been struggling for the last century. This session included a variety of methodologies for accomplishing this daunting task. Presentations on several laboratory techniques for studying weathering are summarized below.

A. Shelford of the University of Portsmouth (United Kingdom) presented a petrographic technique that enables analysis of composition and pore structure. This project, conducted by the National Materials Exposure Programme (United Kingdom), used small blocks of Portland limestone. Photomaps of the surface were obtained by placing a thin section in a photographic enlarger and exposing it directly to photographic paper. The prints were digitized on the computer and used to map surface details and interrelationships between constituent grains, cements and porosity. Further surface mapping was accomplished with GIS image-capturing technologies. These techniques allow for more accurate assessment of the potential performance of a building stone based on its physical and chemical composition.

B. Moroni presented work undertaken by the University of Perugia (Italy) at Foligno Cathedral. The project analyzed the different responses of Carrara marble and a limestone to acidic chemical weathering. The ultimate goal of the project was to optimize conservation treatment of Foligno Cathedral stones. Characterization of these stone and analysis of alteration products revealed that the deterioration processes, although visually similar, are actually induced by different mechanisms. The loss of cohesion in the Carrara marble was attributed to thermal stresses; analogous deterioration of limestone was induced by chemical dissolution of the cement. In Carrara marble, corrosion is highly selective since it develops along the natural fractures and cleavages at the surface of the material. In the case of the limestone, the attack is more generalized since it affects the entire external surface. This understanding allowed conservation treatment to address the different responses of the two stones in the same environment.

W. Köhler from the Labor für Bauwerksdiagnose (Germany) presented his findings on ultrasonic measurements of more than 100 free-standing sculptures, gravestones, and architectural elements composed of Carrara marble. By comparing these measurements with the physical characteristics of the stone (such as compressive and tensile strength, porosity, and dynamic elasticity modulus), weathering processes and deterioration phenomena were identified. The aim of this study is to forecast future weathering of these monuments in order to prioritize them for conservation treatments.

As variation on a theme, studying deterioration mechanisms of a stone may assist in its identification. G. Visser presented research undertaken in northern Germany to identify Elbe sandstone. From medieval times Elbe sandstone was transported to northern Germany from Hamburg and environs and used as building and ornamental stone. Since many quartzitic sandstones are similar petrographically, another method of differentiation was necessary. In Visser's work, deterioration patterns of Elbe sandstone were tracked in various environments in order to understand the decay mechanisms inherent in this type of stone and to develop "fingerprints for recognition".

A similar provenance study on a much larger scale was presented by D. Holzwarth of the Institut für Steinkonservierung (Germany). This project analyzed sandstones from 37 quarries in Germany and characterized their petrographic, geochemical and physical properties. The interdependence of petrographical and physical properties was critically evaluated by several methods. This study was undertaken to define the characteristic weathering patterns of these building stones in various environments, to assist in the conservation of extant structures, and to facilitate knowledgeable choices for future use of the stone.

II. EXPOSURE STUDIES

The papers cited above represented an overview of research topics pertaining to the weathering of stone. However, due to an exponential increase in weathering rates this century, a particular focus on the effects of atmospheric pollution has evolved within the general study of stone weathering.

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The advent of the industrial revolution induced an increase in pollutant concentrations worldwide, due primarily to the use of fossil fuels. Of primary concern in stone conservation is higher pollutant levels of sulfates, nitrogen oxides, ammonia and ozone. These pollutants are deposited on stone monuments either in a gaseous or particulate form — dry deposition — or as a component of precipitation — wet deposition or acid rain. The deterioration mechanisms induced by these pollutants are part of a complex process that is dependent on variables such as concentration of pollutants and their mixtures, relative humidity, temperature, wind speed, and the stone's characteristics.

The interdependency of these factors has been the focus of numerous studies, particularly in the last decade. These include both laboratory and field exposure studies. Field studies allow for the observation of deterioration mechanisms of selected stone types of uniform size and orientation in a specific natural environment. These studies yield information about the relative durability of stones. Determining the contribution of individual variables to deterioration processes is extremely difficult in the field because the variables are numerous, complex and inconstant. Study of each variable's role can be accomplished in the laboratory through the use of simulated environments. Laboratory studies, also known as chamber studies, allow for the isolation and control of environmental variables such as relative humidity, turbulence, wind speed, and temperature. Due to the complexity of natural environments and the numerous types of buildings stones this task becomes long and arduous.

A. Outdoor Exposure Programs

One extensive outdoor exposure program that began in 1992 is the Eurocare-Euromarble project. The program's logo aptly asks "Are we losing our marbles?" S. Simon reported on the findings of seven exposure sites in Stockholm, Goteborg, Moscow, Munich, Vienna, Messina and Arles. Polished and unpolished faces of four different marble types – Carrara, Ekeberg, Laas, and Pentelic – were monitored by non-destructive methods including ultrasonic velocity, surface roughness, color change and water absorption. Simon mentions analogous studies that are being conducted in the United States, the National Acidic Precipitation Assessment Program, and in the United Kingdom, the National Materials Exposure Programme. The major aims of this study are to acquire a deeper understanding of the weathering characteristics and the progressive deterioration patterns of these types of marble. The information is used to develop appropriate conservation strategies for marbles in outdoor environments. Another goal is to correlate the monitored parameters with the environmental data and establish dose-response functions.

A long-term exposure program administered in the United Kingdom is the United Nations Economic Commission for Europe (UNECE) study. Eight years of exposure data for Portland limestone and White Mansfield sandstone were presented by R. Butlin. The specific aims of this program are to determine quantitatively the relationship between pollutant concentrations, climatic parameters, and the deterioration of the two stone types. Based on field observations, correlated with environmental data and laboratory analysis, UNECE has concluded that sulfur dioxide is main contributor to the deterioration of calcareous stones in areas of high pollution. Additionally, the physical evidence demonstrates that dolomitic limestones incur more damage when exposed to acidic precipitation than other types of limestones. Laboratory analysis revealed that the increased loss of dolomitic material (calcium magnesium carbonate), as compared to calcitic material (calcium carbonate) is due to the more pronounced acidic attack on the cementing material of the former. As a result catastrophic loss of whole grains occurs, versus partial dissolution of individual grains. Both of these exposure programs, along with many others worldwide, are on-going.

B. Chamber Studies

F. Giradet of the Laboratoire de Conservation de la Pierre (France) presented the results of chamber studies undertaken at the Lausanne Atmospheric Chamber. This study exposed five stone types — Berne sandstone, Jaumont limestone, Villard sandstone, Rose de Bain limestone, Carrara marble — to ambient environmental conditions. The study demonstrated that increases in relative humidity and temperature increase the reactivity of the stone. The order of reactivity from highest to lowest was Berne sandstone, Jaumont limestone, Villard sandstone, Rose de Bain limestone, and Carrara marble. With the results of this study, classifications of reactive, poorly reactive and non-reactive categories can be defined. The laboratory results closely reflected field observations.

A. Behlen of the University of Hamburg (Germany) reported the results of another chamber study. This project analyzed the deposition velocities of nitrogen oxides on Burkerstein sandstone (a calcitic sandstone) by simulating exposure conditions associated with various seasons. The study determined that nitrate uptake of this sandstone was dominated by the gaseous nitric acid and nitrogen oxide and that the uptake was higher in the summer than in winter. The aim of the study was to devise a method for calculating the rate of nitrate deposition if the concentration of nitrates in the atmosphere is known. The results, displaying good agreement between the calculated values and the measured uptake of the stone samples, are promising.

III. EVALUATION OF SALT DAMAGE

Atmospheric deposition contributes to the formation of salts in masonry. Other sources include ground water, adjacent mortars, fertilizers, de-icing materials, and the stone itself. The analysis of salts in porous materials is of concern since soluble salts are a major cause of deterioration in stone. Salts within a stone's pore system exert pressures on pore membranes when they change phases from crystalline to liquid. Deterioration occurs in environments with fluctuations above and below the deliquescence humidity – the temperature and relative humidity at which this phase change occurs. The deliquescence humidities of individual salts are well documented. In a porous material, however, there is seldom one salt present. Chlorides, nitrates, and sulfates of sodium, magnesium and calcium typically occur together.

A paper addressing the complex interactions of salts was presented by M. Steiger. He provided a chemical model under development at the University of Hamburg (Germany) that examines the phase behavior of salt mixtures. The results predicted by the model have corresponded with observed phenomena of systems with up to four salts present. The model demonstrates three important principles: first, that the deliquescence humidities are lower in mixtures than in a one component system; second, that the crystallization of a salt in a mixture does not occur at a specific humidity value, but rather across a range; and third, that the behavior of salt mixtures cannot be determined by the properties of individual salts. The verification of this model was possible by a new x-ray diffraction technique: ambient XRD. The modified diffractometer allows direct observation of the phase changes while controlling temperature and humidity.

While environmental fluctuations initiate phase changes, the extent of the induced damage is heavily influenced by the physical

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properties of the stone itself. S. Laue presented a case study conducted by an international team from Germany, Switzerland and France that determined the most influential physical properties. The team examined three stone types from within the salt-laden crypt of St. Maria im Kapitol in Cologne (Germany). Although the three types were situated in the same ambient environment, deterioration mechanisms were drastically different. The differences were attributed to varying pore structures. In addition to the traditional methods of pore structure examination – microscopy, mercury-porosimetry and water absorption – a thin section staining technique, employing stains of varying viscosities, was used to track flow processes through the pore structure. The fundamental understanding of salt movement through a porous material that this project provides is essential for developing effective extraction and/or immobilization protocols.

A case study of the S. Maria dei Miracoli Church in Venice, presented by V. Fassina of the Laboratorio Scientific-Soprintendena ai Beni Artistici (Italy) demonstrated how properties of salts influence their movement and extraction. The church exhibited massive efflorescences on the marble slabs. Two primary salt sources were identified. Sulfates were introduced in the Portland cement used during a restoration campaign. Chlorides and nitrates were introduced via rising damp, whose source was a nearby lagoon. The concentration of these three salts were mapped versus the height of the facade. The results corresponded to the solubility of the salts. The less soluble sulfates were found only on the lower portion of the wall, while the more soluble nitrates and chlorides increased with height. Likewise, the ability to extract these salts from the marble slabs corresponded to their solubilities. The less soluble sulfates did not pentrate the pore system and were easily removed in a few days time. The chlorides and nitrates, however, were able to penetrate deeply into the pore system of the marble and after four months immersion in deionized water only 70 percent had been removed. Thus, in order to develop conservation protocols to immobilize or extract salts, one must understand the behavior of salts in an environment, the properties of the salts themselves, and the properties of the host materials.

IV. MOISTURE MEASUREMENTS

At present there is no standardized technique for measuring total moisture within a stone. Techniques currently employed yield only a limited or partial moisture profile of a wall or object. One difficulty is that each of these methods influences the actual water content in the stone. Data collected by these methods—although reproducible—are inaccurate.

One method was presented by F. Weise of Bundesanstalt fur Materialforschung (BAM) – The Federal Institute for Materials Research and Testing (Germany). Moisture content of the main cornice area of the Berlin Zeughaus was measured utilizing a microwave method. This technique can achieve local moisture determinations at various depths. The microwave method is a quasi non-destructive, in-situ technique based on the absorption of continuous microwaves through water-containing materials. Antennas are inserted into the stone at increasing depths to emit and receive microwaves. The results over a twenty-four-month period were verified by laboratory and endoscopic images. This enabled development of a moisture profile of the cornice and identification of the primary sources responsible for excess moisture penetration.

Another approach to measuring moisture was presented by D. Hoffmann, also from BAM. This presentation demonstrated a promising mathematical model that offers a holistic view of the interrelationship between individual parameters. The mathematical model correlates relationships among pore structure and other physical and mechanical characteristics of the stone, including mechanical strength, moisture transport and weatherability. A demonstration of the mathematical model illustrated how a material with a many small pores is more susceptible to frost action than a material with larger pores. The basis of this model is the relationship among the properties such as porosity, specific pore volume, and compressive strength. The aim of the model is to predict behavior based on a few relatively simple measurements.

V. ULTRASONIC TESTING

One theme running through the presentations, and particularly expounded upon by Winkler in his keynote address, was the need for non-destructive testing. One method gaining widespread acceptance is the use of ultrasonic transmission velocity. Ultrasonic methods are frequently used for materials testing and seismic measurements. This non-destructive investigatory technique has only recently begun to gain widespread acceptance for materials assessment in conservation.

The fundamentals of applying this technique to stone monuments were presented by R. Blum of the Laboratorium fur Dynamik und Optik (Germany). The way ultrasound waves travel through a material is a function of the mechanical properties of the material. The ultrasonic velocities are calculated from measurements between the sending probe and the receiving probe. Generally, an increase of ultrasonic velocity in stone measurements indicates an area of deterioration. Blum outlined methods for determining the state of weathering on a monument by ultrasonic techniques, and adaptations for objects that are not fully accessible.

W. Kohler of the Labor fur Bauwerksdiagnose (Germany) presented a case study employing ultrasound as a diagnostic technique. The results of the investigation aided in developing a conservation plan for Vienna's St. Stephen's Cathedral. In addition, the technique was used to determine construction phases on the portal. Sectional reconstructions of the portal were reported to have occurred in two subsequent periods of the thirteenth century, and again around 1500. Since each stone type exhibits a different ultrasound value, utilizing this non-destructive method allowed for identification of three distinct construction campaigns.

W. Murphy, University of Portsmouth, United Kingdom, demonstrated the use of ultrasonic waves as a non-destructive laboratory technique. Coupled with weight change data, acoustic velocity measurements were used to assess deterioration mechanisms of two stone types when exposed to isolated weathering conditions. Monk's Park limestone and Portland limestone were exposed to sodium sulfate in the lab. The results indicated that the Monk's Park limestone was more susceptible to material loss in salt environments. The acoustic measurements indicated a cyclical trend in the weathering mechanism of both stones. Monk's Park limestone experienced a larger degree of internal structural alterations. Also, the stones were exposed to simulated acidic rain and a distilled water rain. The weight change was greatly increased under the acidic precipitation in both stones, while the acoustic measurements indicated very little internal structural alteration under each condition. This suggests that the material loss was from the surface only and that it was chemically induced. Conversely, exposure to salt conditions induces not only a material loss but also an internal alteration of the stone inducing a change in the physical and mechanical properties of these two stone types.

VI. CONSERVATION TREATMENTS

A. Research and Development of Conservation Treatments

As the understanding of deterioration mechanisms and stone properties expands so does the ability to develop and tailor appropriate conservation treatments. In addition, as new laboratory and in-situ techniques emerge, advances in the evaluation of conservation treatments are possible. The result is often not only the development of new treatments but modifications of existing treatments.

Since our monuments sustain catastrophic losses due to pollutants and moisture penetration, consolidation is a treatment that has been a primary focus in the past few decades. Co-author George Wheeler, of the Metropolitan Museum of Art (United States), presented Elizabeth Goins' New York University dissertation on the efficacy of various alkoxysilane consolidants on carbonate stones. It has been well documented that limestones consolidated with alkoxysilanes have significantly lower mechanical properties than do similarly consolidated sandstones. A principle aim of a consolidant is to bond to mineral grains reinstituting their cohesion. It is this cohesion that imparts improved mechanical properties. While the bond between the consolidant and the mineral surface occurs in sandstones it does not in calcitic stones. The study examined several variables that would induce such a bond between the calcitic minerals and the alkoxysilane consolidant. These included the influence of catalysts, water content of the stone, and alkoxysilane coupling agents. Of particular interest is the use of coupling agents, which act as bridges between the mineral surface and the alkoxysilane consolidant. The investigations conclude that phosphato alkoxysilanes demonstrate an affinity for calcite and undiluted amino alkoxysilanes have a chemical affinity for both quartz and calcite. These coupling agents may improve the performance of alkoxysilane consolidants on calcareous stones.

Another study was presented by T. Skoulikdis of the National Technical University of Athens (Greece). This project concentrated on improving the hydrated lime (calcium hydroxide) method for consolidation of calcium containing stones. Historically, this consolidation method has demonstrated a very slow rate of carbonation and a minimal improvements in mechanical resistance. In order to eliminate these disadvantages, various percentages of calcium carbonate were added to the hydrated lime as a catalyst. A mixture of 6 percent calcium carbonate imparted a threefold increase in mechanical resistance. Additionally it was demonstrated that the calcium carbonate accelerated the reaction rate, resulting in a greater depth of carbonation. Moreover, an induction of higher concentrations of carbon dioxide further improved the results. Consolidation of Pentelic marble from the Acropolis with this solution was presented as a case study.

B. Treatment Monitoring

Another important aspect of conservation is the evaluation of in-situ treatments over time. Attempting to move forward without understanding the success and failures of the past is tragically shortsighted. Unfortunately, long-term treatment assessments are nonexistent on most conservation projects and the international conservation community acknowledges it is generally deficient in this area.

In 1987 the Federation of the European Chemical Societies (FECS) formed the Chemistry for the Conservation of Cultural Heritage (CCCH) project in order to provide scientific chemical support to the conservation community. Working parties were formed for Stones, Paintings, and Metals. The first goal of the CCCH was to provide a methodology for "result evaluation". P. Tiano presented a statistical summary of the data collected in Italy. The working group developed a "Conservation Data Collection Form" which facilitates conditions assessment and treatment documentation. They suggest completion of the form every three years. As with any new and large scale endeavor, the CCCH project has imperfections but provides a model for similar treatment assessment programs.

The importance of developing treatment assessment depositories is exemplified by the R. Lofvendahl's presentation of the work of the Central Board of National Antiquities (CBNA) (Sweden). In 1988 CBNA instituted a Conservation Institute. One of the first tasks of the institute was to create a database to track conservation treatments. The institute discovered that 45 percent of all stone conservation projects undertaken since 1988 were comprised of Gotland sandstone and at least twelve had received treatment less than twenty years prior. As a result, CBNA commenced research on this stone type, in use since the Middle Ages throughout the Baltic area, and discovered it was highly susceptible to salts. As a result of this tracking system, treatment and retreatment protocols have been developed for Gotland sandstone.

Other types of evaluations also are necessary. T. Roby of the American Academy in Rome (Italy), presented a long-term assessment of a treatment. Roby's study appraised the condition of ancient marble monuments treated with three different consolidant and protective materials employed during the 1980s in Rome – Paraloid B-72, lime wash, and Wacker OH. Unlike the CCCH evaluations, Roby was not involved in the initial treatments. His methodology included review of published treatment reports, review of private documentation records archived by local administrations or site owners, visual examination and assessment of the monuments, and in-situ testing. Unfortunately, obtaining documentation regarding the treatments was problematic and the number of proven in-situ tests is limited.

VII. CONCLUSIONS

Scientists worldwide are striving to determine and understand why processes associated with stone deterioration occur. With this understanding they can develop treatment methodologies to eliminate or inhibit decay mechanisms. The vast number of building stones used in ever-changing environments makes this a daunting task. Every piece of information, however, adds to the knowledge necessary to preserve our world's historic stone structures. The Berlin Congress certainly added to that body of knowledge and inspired all those involved to continue to tackle this task. Plans are already underway for the next congress which will be held in Vienna in 2000 to enable stone scientists and conservators to once again share their knowledge and advancements in the realm of stone deterioration and conservation.

END

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